



# The Changing Earth Times

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## FISH CONSUMPTION ALERTS RAISE POLLUTION CONCERNS

Fishing advisories throughout the Eastern Canadian Provinces and United States continue to warn people of the possible harm that may come from eating freshwater fish contaminated with mercury (Hg). As mercury pollution falls out of the air with rain, snow and dust it lands on soils and water bodies as part of earth's ecosystem cycles. Once present in aquatic ecosystems, mercury *bioaccumulates* in plants, fish, loons, people and other living organisms (as shown in diagram), increasing our potential for serious health effects.

### What's All the Fuss About Mercury?

Also known as "quicksilver", mercury has had a long, useful and contaminating history for humanity. The Mad Hatter character from *Alice in Wonderland* comes from the felt hat industry of the late 1800's. Mercury was used to make the hats, and workers would absorb and breathe quicksilver to eventually become "mad as a hatter", experiencing hallucinations, delirium and suicidal tendencies. Mercury (Hg), a toxic pollutant can cause reproductive deformities, and long term damage to the kidneys, liver and central nervous system.

### What is Mercury and Where Does It Come From?

As a naturally occurring silver-colored, heavy metal, Hg can be found in small amounts throughout the world in rock, soil, the ocean and atmosphere. It is the only metal that is liquid at room temperature. Similar to other elements, mercury cycles through an ecosystem. Washed out of soils, erupted out of volcanoes, and evaporated from oceans, mercury clings to rain drops, dust and other airborne particles only to fall to earth again. In addition to natural sources, humans emit mercury to the atmosphere.

Large amounts of Hg are emitted into the air when we burn coal, oil, and natural gas and through garbage incineration. There is also discharge of Hg into surface waters from certain industrial wastes and municipal sewage. In a stealthy, subtle manner, mercury is hidden in products we would never suspect, including fluorescent light bulbs, dishwashing liquid, oil soap, and abrasive cleansers. Historically mercury has been used in controlling mildew

Attention Middle & High School Teachers!

### Introducing the Changing Earth Times

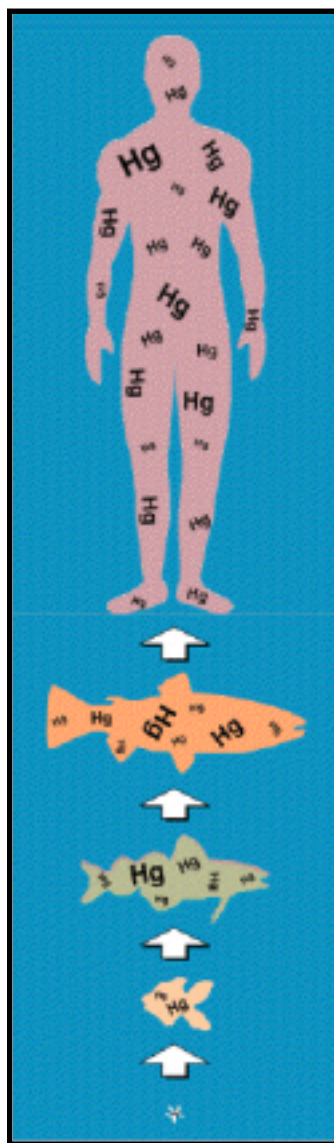
The *Changing Earth Times* is an environmental studies news bulletin for middle and high school students. This issue examines elemental mercury and organic mercury (methylmercury) in the United States and Canada.

What role do humans play in mercury emissions? What are the ecological impacts? What price are we willing to pay for reduced emissions? Students will explore and research these questions through a risk management activity, a biological magnification simulation and a mercury in-the-home check list. The decisions students make will involve economic, social, political and environmental considerations. The content aligns with US national learning standards for science.

The issue of the bulletin was developed for the Conference of New England Governors and Eastern Canadian Premiers (NEG/ECP), a governmental group working to decrease mercury contamination. It was created by Maine DEP, AmeriCorps Environmental Educator JoAnna Greenwood. To learn how to obtain additional copies, visit the internet at <<http://janus.state.me.us/dep/air/outreach.htm>>.

### Informational websites

<http://www.state.me.us/dep/mercury.htm>  
[www.epa.gov/glnpo/p2/mercpam.html#Table](http://www.epa.gov/glnpo/p2/mercpam.html#Table)  
[www.epa.gov/oar/mercover.html](http://www.epa.gov/oar/mercover.html)  
[www.scorecard.org](http://www.scorecard.org)  
[www.epa.gov/students/chemical\\_contamination\\_in\\_fish.htm](http://www.epa.gov/students/chemical_contamination_in_fish.htm)  
<http://wi.water.usgs.gov/pubs/FS-216-95/>  
[www.epa.gov/glnpo/p2/Lkwatchc.html](http://www.epa.gov/glnpo/p2/Lkwatchc.html)  
<http://nadp.sws.uiuc.edu>



Bioaccumulation of methylmercury in trophic levels of an aquatic food chain.

### Biological Magnification Simulation



- 1) Imagine that the front page of this bulletin represents a local lake that is popular with fishermen and contains nesting loons and bald eagles. Each word on the page represents plankton in the food chain. The word "mercury" and "Hg" in the articles represents a bite of plankton that is contaminated with methylmercury that was converted from elemental mercury by bacteria.
- 2) Count the total "bites of plankton" in the "lake" and then the number of contaminated bites. In other words, count all the words, including the word "mercury" and keep track of the number of times the word mercury appears in the article.
- 3) Record data in Trophic Level 1 of the Biomagnification worksheet on the back. Complete the calculation (contaminated bites/total bites=Hg).
- 4) For Trophic Level 2, only 10% of the total plankton intake from the minnows/juvenile fish remain in their bodies and are called "minnow/juvenile fish biomass". Only 10% of the total biomass should be entered in trophic level 2. Fill out trophic levels 3 and 4. Review and discuss numbers. Remember that all of the consumed biomass does not stay in the body. It is turned into waste, heat, motion, and forms of energy that are needed for bodily functions, thinking, walking etc.

#### Discussion/Follow-Up

- ◆ When the mercury was passed from the plankton to the loons, humans, or eagle, was it moving up the food chain or down the food chain?
  - ◆ What happened to the mercury concentration as it went from plankton to people? Would this happen all the time or only sometimes?
  - ◆ Is there a relationship between the food chain and the mercury concentration?
  - ◆ What would happen if you ate more than one fish?
  - ◆ Do you think that all fish that eat from the same lake have the same mercury concentration? Why or why not?
  - ◆ Why do you think the process in this simulation is called biological magnification?
- Adapted from the Biomagnification Activity, NESCAUM.

in paint, for syphilis treatment, and in antiseptic ointments, pharmaceuticals, teething powder and folk medicine. Do you have silver colored fillings in your teeth? Most likely, the dental amalgam contains mercury. Some of the older thermometers contain elemental mercury as well which easily evaporates into the air. If the thermometer accidentally gets broken, you can breathe in the invisible vapor that spills. If Hg gets vacuumed up after a spill, its vapor will spread throughout your home.

### How does Bioaccumulation magnify the problem?

In certain forms Hg is easily incorporated into biological tissue, where it bioaccumulates. This happens when elemental mercury, which has been deposited by pollution or earth's nutrient cycles, undergoes a chemical reaction under water. It becomes transformed into organic mercury or methylmercury by bacteria living in the mud bottom of water bodies. Methylmercury is readily absorbed in the food chain by organisms that eat contaminated plankton and fish. As mercury passes through a typical aquatic food chain, the top predators (fish, humans, loons) may have levels of Hg in their tissue 1,000,000 times greater than the mercury level of the water in which they live. Unlike PCBs and dioxins, which are stored in fish fat, mercury is stored in the fish protein tissue and therefore *cannot* be reduced by removing fat before cooking.

### What can we do to reduce our risk of exposure to mercury?

Sorting out your risk from mercury contamination can be a challenge. You and I make decisions about risks everyday. Being informed will help you to reduce your risk of mercury exposure. Visit the websites listed above to learn which products still contain mercury. And,

- \*avoid buying products that contain Hg whenever substitutes are available, (ie. amalgam fillings, batteries, etc.)
- \*recycle mercury containing products, (ie. fluorescent lightbulbs and batteries)
- \*conserve energy and reduce our reliance on fossil fuels that contain Hg (particularly coal)



Trade-Offs: Your Lights, Your Environment and Your Checkbook

Complete this activity as an individual homework or group class assignment.

Incandescent vs. Compact Fluorescent Lightbulbs- Energy Use, Mercury Emissions and Cost

The largest source of mercury to the environment is coal-burning electric power plants. There is a very small amount of mercury in the coal that is burned to produce electricity. However, because vast amounts of coal are burned, the amount of mercury released up the smokestack is very significant. Compact fluorescent bulbs also contain small amounts of Hg inside the bulb which can be emitted by breaking and incineration. CFL's can be recycled.

One of the largest uses of the electricity produced by these power plants is lighting homes, buildings, and streets. Can the choice of light bulbs in our homes make a difference in terms of the amount of mercury released from fossil fuel burning and the amount we pay for electricity? Let's figure it out by comparing energy use requirements.

Incandescent Bulb	Compact Fluorescent Bulb
A. Energy Requirement.....60 watts.....	15 watts
B. Light Output.....870 lumens.....	925 lumens
C. Average Life.....1,000 hours.....	10,000 hours
D. Purchase Price.....\$0.48 each.....	\$13.99 each
E. Kilowatt Usage/10,000 hrs.....600 Kwhrs.....	150 Kwhrs

- F. Cost of electricity from the power plant = \$0.07 per kilowatt-hour  
G. Pounds of mercury released from coal burning per kilowatt-hour of energy used = 0.0000000369  
H. Percent of electric energy from coal & fossil fuel sources = 60%

- Keep in Mind
- ✓ 1 kilowatt = 1,000 watts
  - ✓ 1 pound = 454 grams
  - ✓ a lumen is a measure of brightness
  - ✓ a kilowatt-hour is a measure of total energy used over a period of time



Adapted From:  
Mercury in Your Community and the Environment, Wisconsin Dept. of Natural Resources, PUB-CE-239 98, October, 1998.

- HINTS:
- \*output/requirement=efficiency
  - \*ExGxHx454=Hg
  - \*(10,000/C xD)+(ExF)=TC
  - \*use # bulbs in your house=lb's
  - population/4=houses
  - houses x lb's = TB

- 1) Which type of light bulb-incandescent or compact fluorescent- is more energy efficient and why?
- 2) After 10,000 hours of use how much mercury (Hg in grams) is released to the environment by energy use due to each of these two types of light bulbs?
- 3) After 10,000 hours of use, what are the total costs (TC), including purchase price and electricity, for each type of light bulb? Remember, however, this does not include the cost to recycle CFL's and dispose of the waste mercury from inside the bulbs.
- 4) Which type of bulb would you recommend? Why?
- 5) Make an educated guess as to how many light bulbs (lb's) are used in your community. Based on your total bulbs (TB) estimate, design a study to determine the differences in cost and in mercury released from energy use, if all those bulbs were either incandescent or compact fluorescent.

### Mercury Search

Check off the items in your home:

Fluorescent lamps

Mercury switches

Thermostat probes

Thermostats-non-electric

Athletic shoes with flashing lights in soles

Thermometers-silver-colored liquid inside

Batteries-mercuric oxide and some alkaline batteries

Clothes irons-automatic or tilt shut-off

Paint- check the label; some oil based and latex manufactured before 1990

Antibacterial products containing thimerosal or merbromin (mechorochrome)

Pilot light sensors in some gas appliances (stoves, ovens, clothes dryers, water heaters, furnaces, space-heaters)

Automotive headlamps (has blue tint when lit)

This list is not complete. What other items might you have?

(You can use the websites on page one to learn about other products with added mercury.)

In the end, we will conserve only what we love...  
We will love only what we understand...  
We will understand only what we are taught.

Chinese Philosopher, Lao-Tsu



Biological Magnification Worksheet

Trophic Level 1

# of Bites of Plankton containing Mercury

Total # of Bites in Lake (plankton biomass)

Mercury Concentration in plankton (in parts per unit [ppu] where units are bites)

(words "mercury")



(100% of words)



(ppu)

Trophic Level 2

# of Bites in the Lake containing mercury

10% of Total # of Bites in Lake (minnow/juvenile fish biomass)

Mercury Concentration in minnows/juvenile fish (in ppu of fish)

(words "mercury")



(10% of words)



(ppu)

Trophic Level 3

# of Bites containing Hg

1% of the Total # of Bites in Lake (predator fish biomass)

Mercury Concentration in the predator fish who eats minnows/juvenile fish (in ppu of predator)

(words "mercury")



(1% of words)



(ppu)

Trophic Level 4

# of Bites containing Hg

0.1% of Total # of Bites of predator fish (student/loon/eagle biomass)

Mercury Concentration in the student/loon/eagle who eats the predator fish (in ppu of student/loon/eagle)

(words "mercury")



(0.1% of words)



(ppu)

Summary Hg in the Food Chain

Hg Concentration in plankton

Hg Concentration in minnows/juvenile fish

Hg Concentration in predator fish

Hg Concentration student/loon/eagle

(ppu)

(ppu)

(ppu)

(ppu)